COMPARISON OF HBA1C LEVELS IN SMOKERS AND NON SMOKERS

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ABSTRACT

Background

Cigarette smoking is a commonly encountered redox state that is known to cause transient elevation in plasma glucose levels. The effect of smoking on long term plasma glucose concentration can be studied by measuring the levels of HbA1c.

Aim

To compare the HbA1c levels in smokers and nonsmokers in order to study the influence of nicotine exposure on long term glucose homeostasis and development of diabetes and its complications.

Materials and Methods

42 adult males in the age group of 24-54 years were recruited for the study. Out of this 20 were smokers and 22 were non smokers. We compared the BMI, Waist/hip ratio, systolic and diastolic BP and HbA1c levels of the cases and controls.

Results

The recorded variables were analyzed using student’s t test. Compared to non smokers, smokers had lower BMI, higher Waist/hip ratio, higher systolic and diastolic BP and higher HbA1c levels.

Conclusion

As smokers had higher levels of HbA1c compared to non smokers, the role of tobacco smoking in producing a sustained increase in the plasma glucose levels have been proved by this study. Nicotine present in tobacco smoke has been implicated in the development of diabetes mellitus and its complications through various mechanisms. Therefore cessation of smoking is important for preventing the development of diabetes and for achieving proper glycemic control and limiting the development of complications in diabetic individuals.

KEYWORDS: Beta-Cells, Diabetes Mellitus, HbA1c, Insulin, nAchRs, Nicotine, Non Smokers, Smokers, Tobacco Smoking

INTRODUCTION

Cigarette smoking is a commonly encountered redox state which generates reactive oxygen species and inflammatory molecules. It is also known to cause transient elevation in plasma glucose levels. The effect of tobacco smoking on long term plasma glucose concentration can be examined by measuring the levels of HbA1c, because HbA1c is a marker of glycemic status over a period of 3 months. The objective of the study is to compare the HbA1c levels in smokers and nonsmokers in order to understand the influence of nicotine exposure on long term glucose homeostasis.
Investigating the association between smoking and HbA1c levels may elucidate the role that tobacco smoking plays in the risk of developing diabetes and its complications and also in glycemic control of diabetics\(^3\).

**MATERIALS AND METHODS**

This is a cross-sectional case control study in done in the Institute of Physiology, Madurai Medical College, and Madurai. 42 healthy adult males in the age group of 24-54 years were recruited for the study. Ethical committee clearance was obtained for the study and informed consent was taken from all the participants.

The study group comprised of 20 smokers who smoked at least 5-10 cigarettes per day for more than 5 years and had moderate to high nicotine dependence according to Fagerstrom test for nicotine dependence. The control group consisted of age matched 22 non smokers. The inclusion criteria for the subjects in both the groups were as follows: they were non obese and not a known case of diabetes mellitus, hypertension, and anemia, hemoglobinopathy or kidney disease. History of blood loss or transfusion was excluded. Alcoholics and those consuming other forms of tobacco were not included in the study.

The study participants were subject to anthropometric measurements. BMI was calculated using formula weight (kg)/ height (m\(^2\)). Waist to hip ratio was calculated from waist circumference and hip circumference. Systolic and diastolic blood pressure was measured in the right arm of the subject in sitting posture using sphygmomanometer.

Random plasma glucose levels was measured using glucometer to know the current glycemic status so that undiagnosed cases of diabetes mellitus with hyperglycemia can be excluded from the study. HbA1c levels were measured by DS5 HbA1c analyser using cation exchange chromatography method.

**RESULTS**

The measured variables were expressed as mean and standard deviation and the data was analysed by Student’s t-test. The test of significance was set up as \(p \leq 0.05\).

**Table 1: Comparison of Results between the Groups Using Student’s ‘t’ test**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Smokers (n=20)</th>
<th>Non smokers (n=22)</th>
<th>‘t’</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
<td>40.1 8.8</td>
<td>37.36 9.48</td>
<td>0.7947</td>
<td>0.4366</td>
</tr>
<tr>
<td>BMI (kg/m(^2))</td>
<td>24.05 3.58</td>
<td>27.07 4.46</td>
<td>1.1626</td>
<td>0.2594</td>
</tr>
<tr>
<td>Waist/HipRatio</td>
<td>0.88 0.09</td>
<td>0.85 0.05</td>
<td>0.7715</td>
<td>0.4499</td>
</tr>
<tr>
<td>Systolic BP(mmHg)</td>
<td>139.8 30.88</td>
<td>128.55 15.21</td>
<td>0.7453</td>
<td>0.4652</td>
</tr>
<tr>
<td>Diastolic BP(mmHg)</td>
<td>91.2 26.01</td>
<td>80.91 10.44</td>
<td>0.8598</td>
<td>0.4008</td>
</tr>
<tr>
<td>HbA1c %</td>
<td>4.41 0.63</td>
<td>4.02 0.4</td>
<td>1.1578</td>
<td>0.2613</td>
</tr>
</tbody>
</table>

The mean BMI was reduced in smokers compared to nonsmokers but the Waist/hip ratio which is a more sensitive indicator of abdominal obesity was increased in smokers. Similarly the systolic and diastolic BP was marginally raised in smokers. The smokers had higher values of HbA1c compared to that of non smokers although the mean HbA1c in both the groups was within the normal range. The association between smoking status and HbA1c remained significant after adjustment of possible confounding factors.
It was also found from this study that the mean HbA1c levels increased with increasing pack-years of cigarette smoking.

**DISCUSSIONS**

Glycosylated hemoglobin is a marker for glycemic control over a period of 3 months. It is formed by a process of non-enzymatic glycation of glucose with N-terminal of the beta chains of HbA. Glycated hemoglobin level, therefore, reflects the average level of glucose to which the cell has been exposed during its life cycle. HbA1c level less than 5.7% is considered as normal, 5.7% to 6.4% as pre-diabetes and 6.5% or more as diabetes. As smokers have higher levels of HbA1c compared to non-smokers, the role of tobacco smoking in producing a sustained increase in the plasma glucose levels on a long term basis have been proved by this study.

Nicotine is recognized as the major pharmacologically active substance in tobacco and it has been implicated in the disorders of glucose and lipid metabolism such as diabetes mellitus and dyslipidemia. The mechanisms by which nicotine causes hyperglycemia are many. Nicotine exposure causes increase in plasma levels of norepineprine and epinephrine which in turn increase hepatic glycolysis and gluconeogenesis. These catecholamines might decrease the number of insulin binding sites and also down regulate the synthesis of glucose transporters.

Tobacco smoking impairs insulin sensitivity by negatively affecting the initial steps in insulin action i.e. signal transduction, glucose transport and glucose phosphorylation. The resulting insulin resistance causes hyperglycemia, hyperinsulinemia and decreased insulin sensitivity. In addition the increased oxidative stress, induced by cigarette smoking, can impair insulin action.

Nicotine also directly influences the secretion of insulin by islet beta-cells by its antagonistic action on neuronal acetylcholine receptors (nAchRs) which are expressed on the islet beta-cells as well as in the pancreatic ganglion. Increased beta-cell apoptosis, loss of beta-cell mass and beta-cell dysfunction has been shown to be induced by direct effect of nicotine via nAchRs. The underlying mechanisms for direct toxicity induced by nicotine via nAchRs are mitochondrial dysfunction, oxidative stress, and inflammation.

Thus nicotine exposure reduces insulin secretion and release, and negatively affects insulin action leading to the development of insulin resistance.
CONCLUSIONS

Increased levels of HbA1c in smokers compared to non-smokers demonstrate the sustained increase in the levels of plasma glucose concentration in smokers. Thus smoking can be considered as an important risk factor for the development of diabetes mellitus and its complications. Because of the insulin resistant state produced by smoking, glycemic control is difficult to achieve in diabetic smokers. Therefore cessation of smoking is important for preventing the development of diabetes and for achieving proper glycemic control and limiting the development of complications in diabetic individuals.

REFERENCES